Global Carbon Cycle Program (GCC)

FY 2000 Information Sheet

The goal of the Global Carbon Cycle (GCC) program, formerly the OACES program, is to improve our ability to predict the fate of anthropogenic CO2 and future atmospheric CO2 concentrations, using a combination of global observations, process-oriented field studies, and modeling. In particular, GCC focuses on atmospheric and oceanic observations, process studies, and global modeling. NOAA's program is a part of the newly formed interagency Carbon Cycle Science initiative of the U.S. Global Change Research Program (USGCRP). For background information on the scientific justification for the integrated carbon cycle program, please consult the Carbon Cycle Science Plan (1999). The approximate funding potentially available under this announcement is $3.5 M. The actual amount of funding available will depend on the FY2000 budget appropriation.

Note-- Letters of Intent will be accepted for this program element until August 13, 1999, an extension past the July 31, 1999 deadline in the Climate and Global Change announcement, and will be replied to by August 31, 1999. Letters of intent may be submitted by e-mail to dilling@ogp.noaa.gov. Full proposals are due October 15, 1999.

P.I.s funded under the GCC announcement may be expected to attend a GCC P.I. meeting approximately every two years to share results and foster collaboration across disciplines.

GCC research is integrated across four over-riding themes:

A. **Global Location, Magnitude and Dynamics of Carbon Sources and Sinks**

A variety of atmospheric, oceanic and terrestrial data has shown that both the ocean and terrestrial biosphere currently take up and store a significant portion of the carbon released to the atmosphere as a result of human activities. Preliminary progress has been made on locating sources and sinks of carbon on a regional basis and characterizing their magnitude and behavior over time. The results obtained thus far are at the limit of detection, however, and cannot be extended to many regions of the world due to lack of data. Optimization studies have suggested a few key terrestrial regions in which to locate additional sampling stations. In addition, large areas of the oceans are currently vastly undersampled for the purposes of quantifying regional oceanic source and sink magnitude and variability. Improvements in sampling technology, spatial coverage, process parameterizations and transport models will greatly improve our characterization of global carbon sources and sinks by region.

B. **Northern Hemisphere Carbon Sinks**

Atmospheric and oceanic data and models have predicted that the terrestrial sink is larger in the Northern Hemisphere than in the Southern Hemisphere. Recent

studies have suggested that a large portion of this terrestrial sink may be located in North America for the period 1988-1992, although there is considerable debate concerning the magnitude and mechanism for this sink. The initial focus of this research theme is to constrain estimates of the Northern Hemisphere terrestrial sink and identify responsible mechanisms using a combination of field experiments, observations, and models.

C. **Causes of Variability in Sources and Sinks**

The rate of increase of carbon dioxide in the atmosphere can vary significantly on interannual and decadal time-scales. The causes of this variability are unknown: while a small amount is a result of variations in emissions, the majority is due to variability in uptake by the oceans and terrestrial biosphere. Several factors have been hypothesized to control this variability, including climate modes such as El Niño-Southern Oscillation, historical and current land use, and CO2 and N fertilization. Studies are needed which investigate how various factors influence global carbon cycle variability over a variety of temporal scales, and identify which factors are the most important.

D. **Future Atmospheric Carbon Dioxide Concentrations**

Current models used to project future atmospheric carbon dioxide concentrations assume that the carbon cycle will continue to operate in the same way it has operated in the recent past. These models do not take into account the limitations of the carbon sink on land, or how biological, chemical and physical processes in the ocean and land might change either due to natural variability or external forcing. For example, it has been suggested that long-term uptake and storage of carbon by the ocean may be reduced by climate change, resulting in an increased proportion of carbon dioxide remaining the atmosphere. By examining the carbon cycle as an integrated system, identifying how it interacts with climate and other influences such as land use patterns, and incorporating the carbon cycle into dynamic earth system models, more realistic predictions of future atmospheric carbon dioxide concentrations and potential abrupt changes in growth rate can be made.

FY 2000 Focus Areas

i. Proposals will be considered to expand the global atmospheric monitoring system to currently under- or unsampled regions, especially the continents and the lower troposphere. Feasibility, siting and/or sampling design studies may be required and will also be considered. Limited support may also be available for maintenance and enhancement of the suite of measurements taken at network sites including oxygen/nitrogen ratios, carbon and oxygen isotopes, and other parameters of direct relevance to the carbon cycle. Proposals should consider the design of the current network, sampling frequency and spatial distribution, potential sampling biases, cost and personnel efficiency,

technological innovation, and how augmentation of the network will contribute to understanding current hypotheses of interest in carbon cycle research. Plans for distribution of data and timelines for release must be included. Proposals must also demonstrate that data will address research in the four themes of the GCC program, as well as the goals of the interagency Carbon Cycle Science Plan.

ii. Proposals will be considered to contribute to the design of a continental-scale CO2 observing system design to allow testing of hypotheses and the extrapolation of site-specific studies, including scaling from local to continental scale, in the context of the Northern Hemisphere terrestrial sink. The initial focus of this activity will be North America, with a look to moving toward a later global focus at lower resolution. As part of an interagency coordinated observation effort, pilot studies will also be considered that seek to implement a design for vertical profiles or continuous "tall" tower monitoring sites for constraining the North American sink.

iii. Proposals will be considered to design and develop the oceanic component of a global carbon cycle monitoring system. Designs must consider the integrated carbon cycle, and should focus on documenting the regional and temporal variability and long-term evolution of ocean carbon uptake and storage, illuminating the major processes responsible for ocean uptake, and identifying the regions most sensitive to changes in uptake due to potential climate change. Designs should consider utilization of existing platforms or sites (such as buoys, floats, satellites, and ships of opportunity) as well as identifying new opportunities, sampling frequency and spatial distribution, cost and personnel efficiency, technological innovation, and how an oceanic network will contribute to understanding current hypotheses of interest in carbon cycle research. Designs may highlight the North Pacific and North Atlantic oceans as an initial emphasis to complement the activities underway nationally and internationally to study the terrestrial component of the carbon cycle in the northern Hemisphere. Plans for distribution of data and timelines for release must be included. Proposed designs may include modest pilot implementation efforts and must demonstrate that data will integrate with research in the four themes of the GCC program, as well as the goals of the interagency Carbon Cycle Science Plan.

iv. Proposals will be considered to conduct field studies of air-sea CO2 flux in the Equatorial Pacific Ocean aboard the NOAA Ship Ron Brown in early spring, 2001. Proposals should focus on understanding a) the kinetics of gas exchange and the factors controlling it, and b) the physical and biogeochemical factors controlling the air-sea pCO2 difference, in the context of developing parameterizations for those factors that can ultimately be remotely sensed to determine regional and global air-sea CO2 fluxes. The anticipated study site is in the region of high pCO2 in the South Equatorial Current (2-5°S) between 110 and 150°W. The transect to the study area would

traverse several oceanographic regions and would allow daylong studies in a range of oceanic environments with different CO2 and surface characteristics. Available shipboard measurements include: salinity, temperature, oxygen, nitrate, chlorophyll and pCO2 from an uncontaminated high capacity bow intake line at nominally 5-m depth, and surface currents using a bow mounted ADCP. Core meteorological measurements would include wind speed, wind direction, rain rate, relative humidity, infrared and visible radiation. Projects should be proposed separately, but may refer to other supporting or complementary efforts. Support for cruise coordination and logistics should be proposed separately from scientific projects. Investigators should make clear any special platform needs, ie. ship modifications, additional boats, or specific sampling requirements, in a separate section.

v. Proposals will be considered to conduct analysis, synthesis and modeling studies using existing datasets or available models to understand the causes of variability in the atmospheric growth rate of CO2 and the natural and perturbed dynamics of the carbon cycle, with the goal of understanding processes controlling carbon cycle variability in the context of the four GCC themes.